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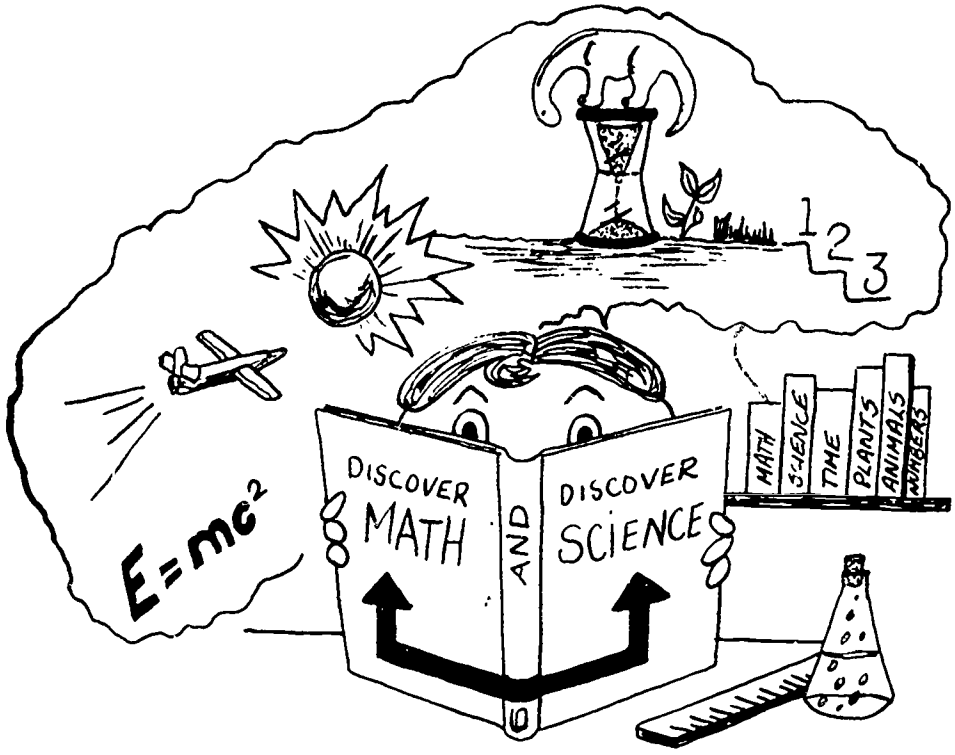
ABSTRACT

The need for teachers to determine whether their students have the skills necessary to learn and to help their students develop missing skills is emphasized. It is felt that it is possible to teach both content and learning skills simultaneously without sacrificing content. This document offers informal, diagnostic testing devices that can be used in developing a composite of the reading skills and deficiencies of learners. Practical activities for the development of reading, learning, and thinking skills are provided. The material concludes with a summary, bibliography of references, and several appendices. It is primarily intended for science teachers, but is felt to be useful to mathematics instructors. It is recognized that science instruction frequently relies upon the concepts and principles of mathematics, and science teachers must employ the reading skills of mathematics to enhance successful instruction of science. (MP)

IMPROVING READING AND STUDY SKILLS IN SCIENCE AND MATHEMATICS



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NSTA Regional Conference
Nashville, Tennessee
November 21, 1981

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FUNCTIONAL READING

To teach only the findings of science is to teach an illusion of scientific knowledge (Paul Hurd, 1970).

Paul Hurd, a respected science educator, does not deny the importance of factual knowledge to learning. His statement may be interpreted as a cautionary message that facts are not ends in themselves, but are, rather, one of several means to a larger end--life. If students are to function as productive citizens, teachers must promote the idea of life-long learning, demonstrate the usefulness of learning skills, and help students apply scientific and mathematical concepts to real situations for solving the problems and issues of the present and future.

Functional reading and study methods are important elements of successful life-long learning. For many years teachers believed they did not have the time to teach both course content and reading skills. Early studies revealed that few content area teachers felt they knew the special reading skills necessary to teach their particular subjects in a way which would help students improve reading and study habits without confusing course content (Olsen, 1968). Further studies found that secondary teachers felt that "without some special training, they were not competent to teach the reading skills needed for their subject" and that this result" ... may explain why many teachers do not believe they have the time to teach reading skills" (Thelen, 1976, p. 1).

Secondary teachers are not expected to be reading specialists. They are regarded as teachers of content. But, for secondary teachers to succeed in teaching their content areas, they must first determine whether or not their students have the skills necessary to learn, then help the students develop any missing skills. It is possible to teach both content and learning skills simultaneously without sacrificing content. The purpose of this booklet is to provide science and mathematics teachers with practical suggestions on how to combine these activities in an efficient manner.

While many books present reading skills for science and mathematics separately, this booklet combines the two content areas for efficiency, simplicity, and because the intended primary readers of this booklet--science teachers--frequently rely upon concepts and principles of mathematics as tools for the teaching of science. As science teachers, we must recognize and employ the reading skills of mathematics to enhance the successful teaching of our own fields.

In the sections which follow, informal diagnostic testing devices are offered for use in developing a composite of the reading skills and deficiencies of your learners. Practical activities for the development of reading, learning, and thinking skills are followed by a bibliography of references cited in this booklet for further study.

INFORMAL DIAGNOSIS

The first step toward solving a problem is recognizing that the problem exists. Like the process involved in solving any problem, recognition of which reading and study skills deficiencies learners have is the first step toward solving the problem. Teachers become aware of student reading and studying problems through teacher-student interactions which are products of classroom teaching methods. These methods can be thought of as instructional processes. One may assume that all a teacher has to do to improve reading and learning is to prescribe improvements in teaching processes and learner study habits. While these two components are important, exclusive reliance upon them to solve the reading problem tends to imply that teachers and learners are solely at fault. The focus of reading improvement can not be aimed at only teachers and learners because at least one other important component exists -- subject content, especially in the form of reading materials. Central to successful diagnosis is the recognition that both content and process, while often separated, are important aspects of successful teaching and learning. Both content and process affect a student's ability to read and learn.

Content is viewed as the accumulation of details, concepts, and generalizations and is reported to determine how conditions of learning are implemented (Thelen, 1976). Selected content should be interesting to the student, significant to the discipline, broadly applicable outside the discipline, and important in terms of its potential for attacking the problems and issues of the present and the future.

Content analysis is the first step in selecting a teaching method. The next step is to examine the process of learning. Process is regarded as "... the reading and thinking techniques that must be utilized to produce a clear understanding of new materials" (Thelen, 1976, p. 4). To select an appropriate process, the teacher must be aware of student background and reading ability, otherwise the teacher may be guilty of what Herber (1978) calls "assumptive teaching."

The teacher, therefore, must first determine the students' abilities to read a given textbook and other reading materials. To this end the teacher must have methods to determine the level at which his/her students can read, the level at which the reading materials are written, the types of reading and study skills used by the students, and indications of areas of students interests. Four methods of informal diagnosis, that is, the determination of student reading skills, reading ability levels, and readability levels of materials, are suggested herein: (1) the Cloze Technique, (2) the Informal Study Skills Inventory, (3) the Student Interest Inventory, and (4) textbook readability level. Examples of science and mathematics applications are often presented concurrently.

The Cloze Technique

The cloze technique, developed by Taylor (1953), can be quickly and reliably used to determine each student's ability to understand a given text. Many studies have reported its accuracy and reliability when administered according to published procedures (Thelen, 1976).

Reading levels of learners are classified as independent, instructional, and functional. Scores provided by the cloze technique are percentages and are translated into these reading levels. The test is constructed by taking a several paragraph passage from the text and deleting every fifth word until fifty blanks are obtained. The first and last sentence of the test should be complete. Proper names and specific measurements of distance, time, or other technical data that the student is unlikely to know are not to be omitted.

The independent reading level is the highest level at which a student can learn on his or her own without teacher assistance. The instructional level is the highest level at which a student can learn with teacher guidance. The frustration level is the text reading level when the student is frustrated in attempts to understand and decode the meanings of the reading material. Materials are considered suited for independent student study if the learner can score above 60% on the cloze technique and are suitable for teacher guided instruction if the learner scores between 60% and 40%. Scores below 40% indicate that students experience frustration while decoding the reading materials. Figure 1 is an example of a science cloze test by Martin (1978) and Figure 2 is an example of a math cloze test. Answers to both tests are located in Appendix A.

are both essential in _____ definition of science. Without _____ collection of facts we _____ not have a basis _____ our thinking. Facts are _____ for thought.

It _____ quite common for people _____ separate the two aspects _____ science and to think _____ science as only the _____ or the other. Some _____, "science is a tested _____ of knowledge." Others say, "_____ is a way of _____." They forget that the _____ are of little value _____ something is done with _____. You need both the _____ about nature and the _____ for arranging them to _____ new ideas about nature.

_____ offers a way of _____ and building a body _____ of knowledge. Technology, on the _____hand, is a way _____ using the facts of _____ to produce new things _____ a better way of _____. While early scientists were _____ heat and the chemical _____, the craftsmen were using _____ to refine metals and _____ elements to make new _____ such as ink and _____.

Through an application of _____ learned by the scientist, _____ technologist produces radios, television _____, and home appliances. He _____ helps the scientist by designing and building better instruments for use in investigating.

Figure 1. Sample science cloze test with instructions to students, by Martin, 1978.
Answers are located in Appendix A.
A score above 60% indicates an independent reading level.
Scores between 60% and 40% indicate an instructional reading level.
A score below 40% indicates the student is reading at the frustration level.

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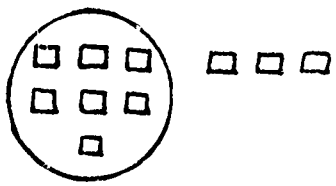
Mathematics Cloze Test

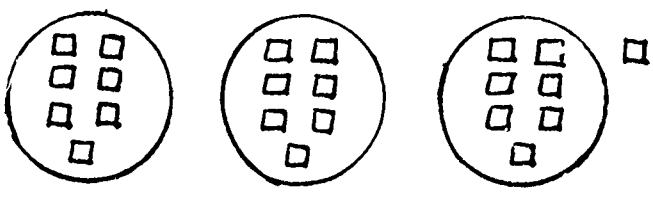
Note: In constructing the cloze test, some teachers use blanks of two standard lengths; for example, fifteen spaces for word symbols and five spaces for numerals and other mathematical symbols. Although this practice tends to give the reader additional clues, its use is defended on the grounds that it preserves the appearance and integrity of mathematical writing, which normally includes numerals and other symbols throughout most printed passages. Also, in order to avoid confusion in indentifying blanks (as opposed to lines separating fractions, for example), some teachers print all lines indicating a deletion in red or some other color.

A Typical Mathematics Cloze Test

Our numeral system uses ten as its base. We are so familiar _____ the base-ten system that _____ idea of using a _____ other than ten as _____ base might seem strange. _____, the Celts, who lived _____ Europe more than 2,000 _____ ago, probably used twenty _____ as a base. Some Eskimo _____, even now, group and _____ by fives. Let us _____ that we take a _____ into space and land _____ the mythical planet Septus, __ _____ the inhabitants use seven _____ the base for their _____ system. If we study _____ numeral system used on _____ planet Septus, it will _____ to give us a _____ and more thorough understanding _____ of our own base-ten system.

_____ the planet Septus the _____ use square coins. Look _____ the coins shown and _____ how they are grouped_____ sevens. Here we see _____ group of seven and _____ more. The numeral that _____ this is $13_{(seven)}$. The _____ $13_{(seven)}$ means "one group _____ seven, and three ones."





_____ we see three groups _____ seven squares each, and _____ extra squares. The numeral _____ indicates this is written _____. The numeral $32_{(seven)}$ means "_____ groups of seven, and _____ ones."

In our modern _____ system we do not _____ to write the base _____ everybody understands that the _____ is ten. For example, _____ the decimal system the _____ "27" means two groups _____ ten, and seven ones _____ 27 = (2 x 10) + _____. However, when we use _____ other than ten, we _____ indicate the base that _____ are using.

In our decimal system we use the ten symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Figure 2. Sample Mathematics Cloze Test. (From Mathematics: A Modern Approach by M. Peters and W. Schaff, p. 41. Copyright 1971 by Litton Educational Publishing, Inc. Reprinted in Earle, 1976 by permission of Van Nostrand Reinhold Company.)

Note: The key to this test is included in Appendix A.

The Informal Study Skills Inventory

Informal study skills tests are teacher constructed instruments and should be used with the course text. Using the skills listed in Figure 3 as a guide, the teacher can include items on the inventory which will assess skills needed by the students to understand the text, then, based upon the test results, identify the skills that students don't have. For ease in scoring, each item should be labeled to indicate which skills it represents. Examples of informal study skills inventories and convenient checklists are located in Appendices B, C, and D.

After scoring the study skills inventory, record each student's skills on a class analysis chart similar to the one in Figure 4. If the skills inventory is given early in the year, the results can be used for long range planning to develop weak or missing skills. It is suggested that student scores be recorded as follows:

1. Leave the space blank if the student has demonstrated the acceptable skill competence.

2. Use a single check (✓) if the student has some difficulty with the skill.

3. Use a double check (✓✓) if the student has extreme difficulty with the skill.

By reading the chart vertically, an indication of those skills which need to be taught to an entire class can be seen.

Skills Needed For Reading In Science And Mathematics

The most commonly needed skills for reading in science and mathematics are described below. For science and mathematics general areas are similar, but the specifics may differ according to content.

Vocabulary Skills

1. Learning and recognizing terms that are unique to science, e.g., photosynthesis, phylum, stromata, multicellular, and mathematics, e.g., perpendicular, quadrilateral, congruent, numerator, denominator.

2. Learning scientific and mathematical meanings of common words, e.g., culture, power, belt, square root, improper fractions, reduce.

3. Learning scientific and mathematical symbols and abbreviations, e.g., H_2O, Fe, $<$, $>$, $\leq$, :, $\div$, deci, centi, kilo.

4. Understanding how new words are coined and enter our language, e.g., astronaut, shuttle, NASA, byte.

5. Consider also the heavy emphasis of technical vocabulary respective to the level and difficulty of the reading materials.

Locational Skills

1. Using graphs, charts, tables, figures, and diagrams.

2. Using a glossary of terms.

3. Using tables of contents, indexes, and appendices.

4. Using chapter headings and subtitles.

Comprehension Skills

1. Selecting significant details, recognizing main ideas, classifying covergently, following directions, determining sequence, compiling data in graph, map, or chart forms, reading charts and graphs.

2. Formulating main ideas from data, classifying comparing and contrasting, determining cause and effect relationships, applying ideas to new problems or situations.

3. Dissecting, analyzing data, establishing the validity of information sources, determining the author's purpose, recognizing irrelevant information, establishing cause and effect relationships, deductive reasoning, synthesizing ideas, divergent inquiry, problem solving, reading formulas, identifying patterns, evaluating.

Comprehension and Appreciation Skills

1. Developing the habit of extended and intensive reading in science and mathematics -- for greater cognition and appreciation.

Speed of Comprehension Skills

1. Developing the ability to adjust reading speed according to the purpose and difficulty of materials.

Other Skills

1. Ability to classify and measure

2. Organizational skills, notetaking, recording data/measurements, critical reading.

Figure 3. Reading and study skills needed for science and mathematics. Excerpted from Burmeister, 1978.

Figure 4. Reading and Study Skills Class Analysis Chart

Textbook _____ Subject _____ Grade _____

NAME	SKILLS FROM INFORMAL INVENTORY																								COMMENTS
	Vocabulary						Locational						Comprehension							Other					
	Using Symbols	Using Prefixes	Using Context	Using Abbreviations	Teaching Vocabulary		Graphs, Figures, etc.	Using Chapter Headings	Use of Glossary	Tables of Contents, Indexes	Appendices		Following Directions	Determing Sequence	Organizational	Comparing and Contrasting	Problem Solving	Cause and Effect	Analyzing Data	Extended Reading	Adjusting Reading Speed	Notetaking			

The Student Interest Inventory

Just as it is vital to learn what a student's abilities are, it is necessary that his/her interests can be considered when materials are selected. Student interests can be identified through questionnaires in addition to teacher observations. Questionnnaires are an effective means of gathering information concerning interest patterns related to specific courses or topics. Most questionnnaires may be used in a group testing situation and can gather information about leisure activities, work, reading habits, travel, and hobbies. These questionnaires may be commercially printed or teacher-made.

Information obtained from the student by a teacher can serve in understanding the segments of reading interest which a student has as related to a specific course. Knowing the kind of books which students enjoy can assist the teacher in recommending books which may be interesting and motivating to the reader. Assignments can be directed toward the areas where the student is most highly motivated, thus accentuating the student's interest in the course and desire for reading. The student will thereby place greater confidence in the teacher as a source of information for new book selections. Figure 5 is an example of an informal general science student interest inventory.

The Readability Level of Textbooks

"Readability" is the term used to cover various aspects of written materials which determine the reading difficulty of a printed page. Readability means "difficulty" with the result that

STUDENT INTEREST INVENTORY (General Science)

Part I. CHOOSING FAVORITE SUBJECTS. Number the subjects you would like to study in class this year. Number in order of preference. 1 - most favorite to 12 - least favorite.

___The Chemistry of Matter
___Nucleonics
___Energy and Machines
___Heat
___Wave Energy
___Electrical Energy
___The Atmosphere
___The Hydrosphere
___The Geosphere
___The Earth in Space
___Living Things
___Ecology

Part II. STUDENT INTERESTS AND ACTIVITIES

1. When you have an hour or two to spend as you please, what do you like to do?_____

2. What do you usually do:

   After school?_____
   In the spring?_____
   On Saturday?_____
   On Sunday?_____

3. What activity do you like to do best:

   In the summer?_____
   In the winter?_____
   In the spring?_____
   In the fall?_____

4. Do you play a musical instrument? Yes____ No____
   If yes, name the instrument(s):_____

5. Do you have a home computer? Yes____ No____
   What programming languages do you know?_____

6. Do you have any video game(s)? Yes____ No____
   If yes, what are they?_____

7. Do you own a calculator? Yes____ No____
   If yes, what functions does it have?_____

8. Do you have any pets? Yes____ No____
   If yes, what are they?_____

9. Do you have any hobbies? Yes____ No____
   If yes, what are they?_____

10. Do you have a TV set at home? Yes____ No____
If yes, how much time do you spend viewing TV:

Each weekday: _____hours; Saturday: _____hours; Sunday: _____hours

11. What are your favorite TV programs?

A._____ D._____
B._____ E._____
C._____ F._____

12. List some TV programs you do not like:

A._____
B._____
C._____

13. How often do you go to the movies?_____

14. Name a movie you have seen recently that you liked very much:

_____

15. What kind of work do you want to do when you graduate from high school?_____

16. What school subject do you usually like best?

_____

17. What school subject do you like the least?_____

18. Do you usually like science and math classes? Yes____ No____
Why or why not?_____

19. Do you read regularly? Yes____ No____
If yes, what do you read?_____

20. Do you have a dictionary at home? Yes____ No____

21. Do you have an encyclopedia at home? Yes____ No____

Part III. Put an "X" beside each item in which you have some interest:

1. eagles
2. whale
3. the ocean
4. stars
5. planets
6. trees
7. flowers
8. space
9. rockets
10. airplanes
11. flight
12. Star Trek
13. fossils
14. rocks
15. prehistoric man
16. dinosaurs
17. fish
18. snakes

19. lions
20. African animals
21. genetics
22. time
23. Albert Einstein
24. Sir Isaac Newton
25. Thomas Edison
26. Copernicus
27. nature
28. Neil Armstrong
29. wildlife
30. ecology
31. recycling
32. population control
33. the future
34. telescopes
35. microscopes
36. pollution
37. Mars
38. technology
39. communication
40. speed of light
41. infinity
42. meteors
43. mummies
44. bees
45. raccoons
46. water
47. explosions
48. experiments
49. soil
50. insects
51. germs
52. diseases
53. the body
54. weather
55. navigation
56. astrology
57. solar system
58. solar power
59. fuel crisis
60. atomic power
61. strip mining
62. food production
63. reproduction
64. deserts
65. mountains
66. Alaskan oil
67. life
68. death
69. scientific mysteries
70. mapping
71. orienteering
72. mountain climbing
73. architecture
74. logic games
75. sports statistics
76. brain teasers
77. recipes
78. savings and interest
79. card and die probabilities
80. puzzles, rubic's cube, etc.
81. other: please state choices.

Figure 5. Student interest inventory (General Science).

books which are very difficult to read are described as being of "high readability," and books which are very easy to read are described as being of "low readability."

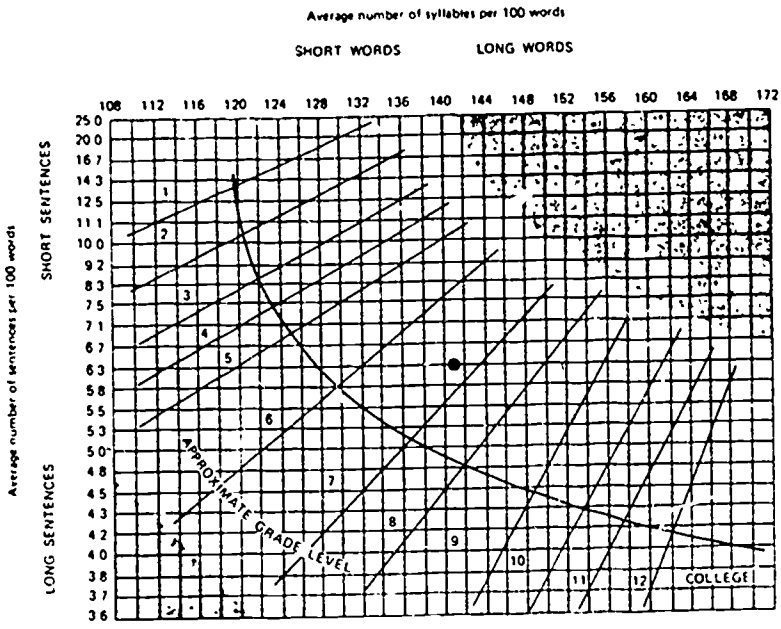
Another step in providing appropriate reading for students and assisting the development of reading/study skills is to measure the readability of the print materials and match the level of the reading materials with the identified reading success levels of the students.

Formulas exist for determining the readability of a text. This "readability formula" may be defined as an objective method of measuring several components of writing. When considered in relationship to each other, these measurements result in a quantitative estimate of the reading difficulty of the samples taken from the text. Several of these components are: (1) the length of sentences; (2) the types of sentences, e.g., simple, compound, and complex; (3) the complexity of sentences; (4) the vocabulary used; (5) the abstractions and abstract concepts used in the text; and (6) sophisticated usage of the parts of speech.

The Fry Readability Formula permits simple measures of readability and a detailed analysis of sentence and word length. The resulting measure is a numerical readability value which is also a grade level equivalency. This formula also considers idea density and complexity of vocabulary and main ideas. The longer the sentence and its individual words, the more dense and more complex are the ideas. Figure 6 contains directions and a graph for determining readability according to the Fry formula.

GRAPH FOR ESTIMATING READABILITY

by Edward Fry Rutgers University Reading Center New Jersey



Directions for Working Readability Graph

1. Randomly select three sample passages and count out exactly 100 words beginning with a beginning of a sentence Don't count numbers. Do count proper nouns.
2. Count the number of sentences in the hundred words estimating length of the fraction of the last sentence to the nearest 1/10th
3. Count the total number of syllables in the 100 word passage. If you don't have a hand counter available, an easy way is to simply put a mark above every syllable over one in each word, then when you get to the end of the passage, count the number of marks and add 100
4. Enter graph with average sentence length and number of syllables, plot dot where the two lines intersect Area where dot is plotted will give you the approximate grade level
5. If a great deal of variability is found, putting more sample counts into the average is desirable.

For further information and validity data see the April, 1968 *Journal of Reading* and the March, 1969 *Reading Teacher*.

Figure 6. Fry readability formula.

Readability Barriers

After print materials which correspond to the student's instructional reading level have been selected, the teacher should then locate problems within the reading assignment which may function as barriers to the individual student's reading. The primary barriers which create difficulty consist of: vocabulary, sentence structure, relationships, and levels of abstraction.

By providing additional oral or written information to the student as a part of an organized process, such as a study strategy or teaching strategy, the teacher may find it possible to overcome each of these barriers and effect more efficient learning of course content. The teaching/study processes and activities presented in the next chapter are designed to assist teachers in helping students overcome barriers to reading and learning.

READING/STUDY SKILL IMPROVEMENT STRATEGIES AND MATERIALS

Student preparation for learning new materials is essential to successful learning. If students are directed to "learn" new material before mastering the process of studying for meaningful learning, they may become frustrated and resort to learning by rote. Frustrated students often send verbal and nonverbal signals to teachers asking "What is important?" and "What must I learn?" These signals are a call for assistance with study skills by providing specific direction for the reading and study task.

Any content area teacher has the responsibility to structure lessons, including reading assignments, through a process which will facilitate student development of skills critical to successful learning. Teachers of content areas which routinely utilize technical or specialized vocabulary, such as is commonly found in science and mathematics, find student mastery of reading and study skills to be especially important to the development of independent learners.

Teaching Strategies

A strategy which has been found highly effective in assisting large groups and entire classes of students with required reading is the directed reading activity (DRA) -- a teacher-directed learning process. Five steps are included in a DRA: (1) exploring the backgrounds of students as related to the reading materials; (2) setting up purposes for reading which direct students to focus on major points; (3) silent reading of the assignment (can be assigned as homework); (4) follow-up

activities which can be teacher-directed or inquiry-oriented; and (5) extend the activity to complementary areas or practical life situations. Descriptions of each step follow.

Step 1. Exploration, background building, and motivation. Gather information about the background and skills the students will need to understand the assignment and compare with the skills the students have. When it is apparent students have insufficient information, build their backgrounds and skills so they can understand the assignment. Relate the assignment to previous learning and motivate students so they will wish to read the materials. The following activities may be helpful in accomplishing Step 1.

1. Review previous assignments, readings, and laboratory assignments.
2. Present word attack skills for review or new words. Include references to syllabication, context clues, and meanings of prefixes and root words. Provide vocabulary lists.
3. Review, or teach for the first time, comprehension skills necessary for understanding the assignment.
4. Review, or teach for the first time, a critical reading/thinking skill, such as distinguishing fact from opinion, observation from inference, a hypothesis from a problem, using facts to solve a problem, recognize faulty experimental techniques and factors that need to be controlled, analyzing data to determine its value and reliability, applying generalizations to new situations, and using evidence to support conclusions.
5. Use appropriate media to build the students' backgrounds.
6. Show a picture or concrete example so that students can better visualize what will be discussed in the assignment.
7. Have a speaker knowledgeable about the subject or a related subject talk to the class.

Step 2. Preview and clarify purpose. Setting the purpose for the assignment consists of two substeps: (1) preview the assignment by using a survey or skimming technique (see study techinques); and (2) state the purpose, or better still, have the students state the purpose

of the reading. Purposes might include the following:

1. The acquisition of specific information necessary to the completion of more complex tasks, e.g., meanings of technical words from context, getting main ideas, determining sequence, following directions.
2. Specific questions about intrepretations, e.g., "What will happen to C if B instead of A occurs?"
3. Eliciting critical thinking reactions, e.g., Are any faulty experimental techniques used? What evidence is used to support conclusions? What practical applications do these general principals have?
4. Affective responses or reactions, e.g., How do you feel about . . . ? Does the solution of the problem seem fair to you? Why?

Step 3. Student silent reading. Assign as homework or provide students time to read the material.

Step 4. Discussion or response. Follow up activities are very important to the development of skills and learning of content. The teacher must decide what skills and concepts are to be developed and how the lesson will be conducted. Some possibilities include the following:

1. A teacher directed discussion, an extended focused assignment, or quiz. These strategies are particularly useful when convergent thinking is desired. Questions are asked by the teacher and students respond -- orally, in writing, or by performing a task -- to ensure that specific learning occurs.
2. Nondirective, or inquiry centered activities. These activities are accomplished best when the teacher is not an imposing authority figure. Students must be free to respond to or think about an activity in a creative environment. The teacher's task is one of facilitating the learning process by prodding students, providing stimulation, or encouraging students to defend statements or choices and clarify points they make.

Step 5. Extend or enrich. Extension of the activity might mean proceeding to the next chapter or having students do related reading or practical application activities. The original assignment might lead to related reading of personal interest, interviews or correspondence with authority figures, field trips, self-planned experimentation, or the

identification and solution of environmental problems.

The above general teaching strategy may be applied to nearly any content area. Specific or highly specialized content areas such as science and mathematics may require some modifications of the strategy to address the specific skills which need development. The reader may recall that some of these specific skills previously were listed in Figure 3.

Study Strategies

Study strategies can be used as a supplement or substitute for a teacher directed reading activity when students are capable of working at the independent reading level or when the teacher wishes to provide students with experiences to prepare them for independence. Burmeister (1978) provides a general study method, SQ3R, which can be used for independent or instructional readers and can be helpful as a teacher directed or student directed reading activity. Parts of the strategy can even be built into a DRA. Burmeister's study strategy is represented by the following flow chart. The steps are explained below.

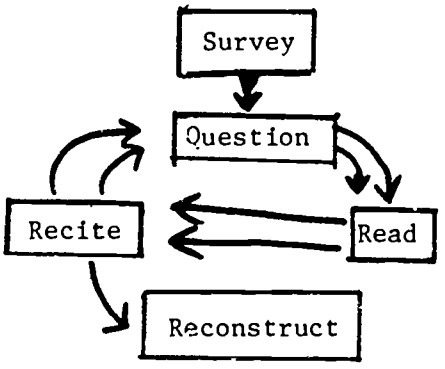


Figure 7. SQ3R study stragegy

Survey: skim the reading material, noting its organization, components of content, pictures, graphs, charts, and so on.

Question: look at the main headings and ask what do they mean or what are they about.

R_1= Read: read to find out answers to your questions. If the answers are not readily available, seek them elsewhere.

R_2= Recite: recite the answers to yourself to help your memory. Do the answers make sense? Do they fit the intent of the assignment? Go to the next section of the reading and repeat the above procedures until you have finished the reading.

R_3= Review or Reconstruct: review the entire assignment in a survey fashion, making note of the details you have discovered. Try to reconstruct the reading assignment by writing an outline and try to recall important details. Try to interpret what the author has written and think of ways to apply the information. At this point you may wish to extend your reading to other materials.

Variations of the SQ3R strategy are suggested in the literature. Two variations follow, one for science and the other for mathematics. Both variations can involve teacher direction.

For science -- PQRST

1. Preview: rapidly skim the total reading selection.
2. Question: raise questions which guide careful reading in terms of study purposes.
3. Read: read the assignment while keeping the question in mind.

4. Summarize: summarize and organize the information gained by the reading.

5. Test: check your memory against the assignment.

For mathematics -- SQRQCQ

1. Survey: read the problem quickly to determine its nature.

2. Question: question what is being asked and determine the problem.

3. Read: find details and relationships.

4. Question: what problem-solving and computational processes should be used?

5. Compute: carry out the computation.

6. Question: does the answer seem correct? Check the computation against the facts.

The above study strategies are designed to help students with their silent reading. Class activities which follow the reading assignment are important to the development of specific reading and thinking skills because the activities cause students to practice behaviors necessary for skill development. The sample activities in the sections which follow are designed to build and reinforce vocabulary, assist reading comprehension, and promote higher levels of cognitive development.

Vocabulary Development

Scientific and mathematical writings present unique reading problems to students. In both disciplines each line of text tends to contain more precise information than is usually encountered elsewhere. Both are written in a terse, factual style that utilizes highly specific, technical vocabulary, often devoid of contextual clues. Also, there is a heavy reliance on symbols to represent one or more words. The following activities represented by Figures 8, 9, 10, are suggestions of how to help students cope with the highly specialized vocabulary common to these areas.

Word Hunt

Purpose: for developing an understanding of vocabulary common to science and mathematics.

Directions: Find and circle the words whose definitions are listed below

A	G	U	D	I	G	I	T	V	Y	R	S
N	I	N	M	C	O	N	S	M	M	P	T
O	Y	I	E	R	E	W	L	O	S	A	W
O	T	A	T	C	O	R	A	D	E	R	V
G	R	E	R	L	S	W	R	E	T	A	E
I	E	E	I	E	V	E	S	L	A	L	C
M	P	L	L	P	A	I	B	C	N	L	N
P	O	A	M	E	R	G	E	D	I	E	A
G	R	M	T	R	L	H	L	F	D	L	T
K	P	I	E	P	M	T	O	H	R	F	S
L	E	C	N	E	T	G	B	J	O	B	I
L	O	E	T	U	N	I	N	S	O	D	D
E	A	D	S	M	N	T	Y	U	C	E	A
Y	R	T	E	M	M	Y	S	I	S	E	R

1. _____any numeral from zero to nine
2. _____a written mark for an object
3. _____points on the X and Y axis of a graph
4. _____successive steps in a series
5. _____two lines or planes that never intersect
6. _____length of an object multiplied by its width
7. _____the attraction of gravity on an object

8. _____based on the number ten

9. _____characteristic or quality of something

10. _____interval between two points

11. _____measurement system based on the decimal system

12. _____a hundreth part

13. _____a small copy or imitation of an existing object

Figure 8. Vocabulary Word Hunt Puzzle.

A list of words common to science and mathematics is located in Appendix E.

Understanding the Use of Symbols - Junior High and above

"Symbolic Language"

1. Have students generate a list of commonly recognized symbols. Start them out with a few examples such as: 7-11, VW, RCA, golden arches, states shapes, symbol for pure wool.
2. When the list is completed, have the students select five or six. Then ask each student to write a short selection including those items, in each case, using the symbol in place of the word.
3. Have students generate their own original symbols. These should avoid print or alphabet letters, relying instead on created designs. Each student should then write a brief story consistently using the created symbol.
4. Duplicate student stories so students can attempt to decode other symbols from the context of the stories. Each author should prepare a decoding sheet so students can check their level of success.
5. Discuss the importance of symbolic language for science and math texts. Students should then write a brief selection, using the symbols of the course. Have students exchange their selections as above.

Figure 9. Symbolic Language

Excerpted from Smith and Elliot, 1979, p. 214.

Classifying Vocabulary: to classify vocabulary common to a given concept and to aid in understanding.

Grade Level 10

Directions: Categorize the following list of words. You are given three main headings: Circles, Triangles, Quadrilaters. Some words may come under more than one category.

arc	center	median
radius	trapezoid	rhombus
diagonal	diameter	acute
obtuse	isosceles	central angle
mean	square	scalene
rectangle	equilateral	tangent
concentric	circumference	right
convex	parallelogram	vertice

Figure 10. Vocabulary classification exercise

Excerpted from Miller, 1974, p. 397.

For a list of some words common to Mathematics and Science, see Appendix E.

Following Directions

Successful completion of experimental investigations or complicated verbal problems require that students be able to follow written and oral directions. Planning skills, attention to details, and understanding key signal terms are important considerations. The following activities in Figures 11 and 12 are designed to assess and/or teach these necessary abilities.

Following Directions: Middle School and Up

(Scavenger Hunt)

Hide an object in your classroom, building or outdoor area. Plant clues that describe tasks to be completed in order to find the object. The clues can ask students;

Measure 5 meters from the wall or solve for X when Y=5 if X=4y+5 then walk that number of meters to your right.

Provide each student with a different set of clues. The first student to find the object according to his or her clues wins.

Figure 11. Scavenger Hunt

Adapted from Lapp and Flood, 1978.

Following Directions and Map Reading - Secondary Level

Assign students the role of travel agents. Give each student a different type of trip itinerary to prepare such as different states or countries or vacation and business trips. Students can locate such data as:

most scenic route	costs
fastest route	types of clothing needed
points of interest	state and national parks
mineral desposits	astronomical observatories
wildlife preserves	bike routes

Students can augment these itineraries with brochures, posters or oral reports. Have students exchange their itineraries with other student "clients." Give students maps so they can evaluate the clarity of directions and their ability to follow the directions.

This activity can be enhanced by having students plan trips that can actually be taken. If you teach astronomy use sky maps to plan imaginary trips through the galaxy.

Figure 12. Map reading.

Graphing

Mathematical and scientific texts rely heavily on visual representations of information contained in the text. While intended to facilitate a student's understanding of written information, graphs, charts, tables, and diagrams present additional reading challenges. Activities represented in Figures 13-17 offer suggestions for helping students understand the large amount of information contained in a graphic format.

Understanding Picture Graphs

Have students collect data from the classroom, building or the outside environment. Students can measure such features as;

temperature variations throughout the room, building, or grounds

local land elevations

soil samples

population variation

animal populations in an area

Using a code and maps the students can design a picture map showing the variations they have observed.

Figure 13. Picture graphs.

Constructing Math Tables

Have students choose a topic with which they can survey the rest of the class or school. Possible topics might include present jobs, future careers, favorite or least favorite school subjects, favorite foods, hours spent watching TV, or hours studying.

Have students accumulate their data and organize it in tabular form.

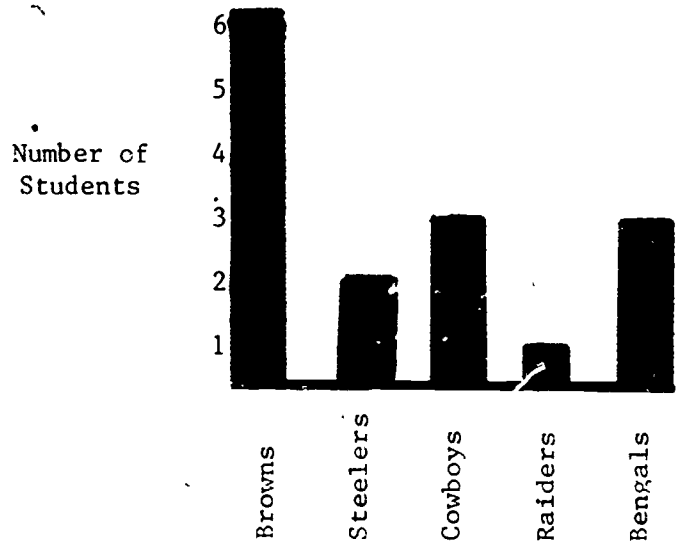
Favorite Snackfoods of Classmates	Number of Students	Percentage of Total
Pizza	10	37.04
Cheeseburgers	8	29.63
Potato Chips	5	18.52
Cookies	3	11.11
Candy	1	3.70
TOTAL	17	100.00

Figures 14. Constructing Mathematics tables

Constructing Histograms

Have students interview other students to obtain data. Students could find out favorite TV shows, months of birth, astrological signs, favorite sports teams or any other topic that they wish to investigate.

Have students tabulate the data and construct histograms to show student responses in each category.



Favorite Football Teams

Figure 15. Constructing histograms.

Interpreting Information Portrayed Through Graphs

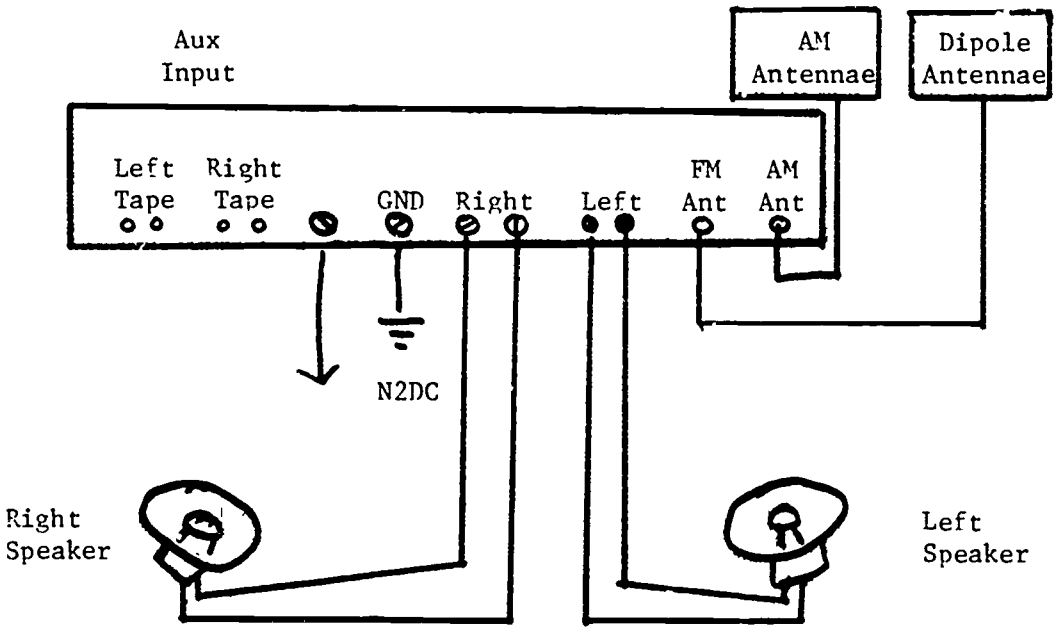
From an interest inventory select a topic of interest for a student where data fluctuates on a regular basis. Some topics might be batting averages, quarterback ratings, daily high and low temperature, stock prices, time of sunrise and sunset or gasoline prices.

Students can obtain the data and graph it to discern trends. This activity can be coordinated with a language arts study of the newpaper to privide a ready access of data.

Figure 16. Interpreting graphs.

Understanding Diagrams

Give students a diagram from an area of common interest such as a stereo system.



1. Have students examine the diagram and then direct them in sorting out the following pieces of information obtained from it:

   A. Where does the sound come from?
   B. What are the units power requirements?
   C. What function is served by the FM antenna?
   D. What does the symbol ⏚ mean?
   E. Why are there two sets of outputs?
   F. If one secured a tape playback unit, could it be connected for use with this receiver? Where would one make such a connection?

2. Have students gather diagrams of things they are interested in through hobbies, other courses, jobs, etc. Have them create a series of questions to go with the diagrams and an answer key. Students can then teach others who have difficulties reading diagrams.

Figure 17. Understanding diagrams.

Excerpted from Smith and Elliot, 1979, p. 222.

Solving Word Problems

One of the most difficult tasks encountered by students in mathematics and science, particularly in physical science, is the completion of problems presented in a verbal or written form. Before computation can begin, students need to be able to comprehend what the problem is about and what they are attempting to find. With many students, their approach to the reading of the problem is the source of difficulty. To help students to solve word problems teach them to follow a step by step procedure to encourage careful reading and planning. Suggested steps follow (Thomas and Robinson, 1977), Steps For Solving Word Problems In Science And Math.

Step 1. Read the problem thoroughly asking "What is this all about"?

Step 2. Reread the problem asking "What am I to find here"?

Step 3. Ask yourself "What facts are given"?

Step 4. Plan your attack

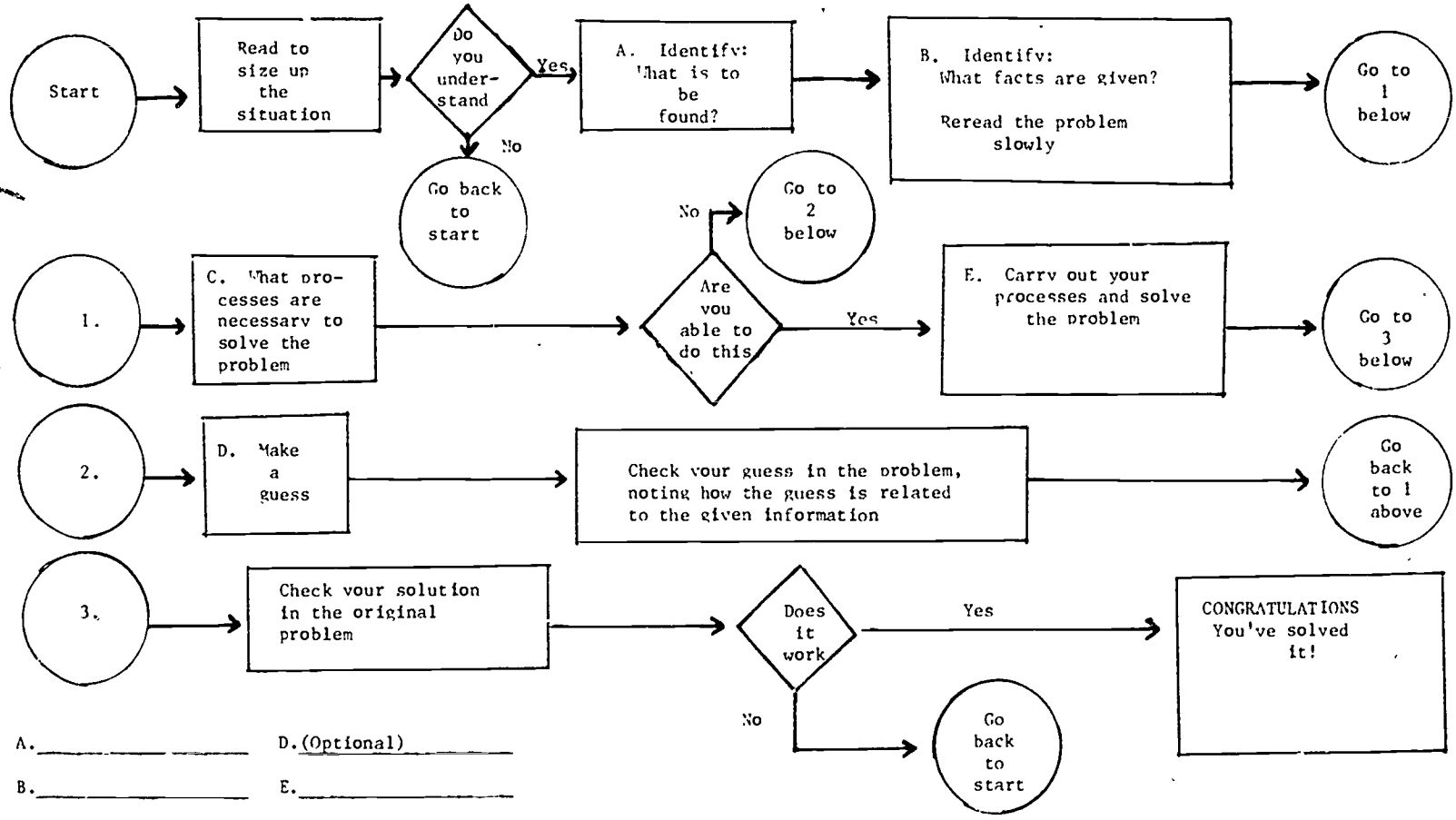
Step 5. Estimate the answer (see example in Appendix F Solving Science/Math Problem Prediction Sheet).

Step 6. Carry out the operations.

Step 7. Check your work.

An individualized instructional strategy is helpful in the management of solving word problems. For example, ... A learning center can be constructed where students can work independently on problems designed to correct deficiencies with particular steps in solving word problems (Appendix G provides a sample of this). The flow chart in Figure 18 may serve as a guide for helping students.

Figure 18.


Start
Read to size up the situation
Do you understand
Yes
No
Go back to start
A. Identify: What is to be found?
B. Identify: What facts are given?
Reread the problem slowly
Go to 1 below
No
Go to 2 below
1.
C. What processes are necessary to solve the problem
Are you able to do this
Yes
E. Carry out your processes and solve the problem
Go to 3 below
2.
D. Make a guess
Check your guess in the problem, noting how the guess is related to the given information
Go back to 1 above
3.
Check your solution in the original problem
Does it work
Yes
CONGRATULATIONS You've solved it!
No
Go back to start
A.
B.
C.
D.(Optional)
E.

Comprehension Development

The previous activities help students develop reading and study skills. Some activities were designed to develop vocabularly skills or help students follow directions, others were designed to improve basic skills necessary for students to understand -- to comprehend -- more difficult tasks.

Comprehension is the act of getting meaning from printed or spoken language and is considered an all-encompassing term representative of all the skills and abilities involved in getting meaning from printed or spoken language. Skills and abilities requisite to the getting of meaning may be classified as literal, interpretive, and applied comprehension.

Literal comprehension is represented when students understand the direct meaning of words, for example, recalling details or facts in a reading selection. Interpretive comprehension means that students demonstrate the implied meanings of words, for example, locating main ideas when an author has not stated them directly. It is important for students to comprehend interpretively so they can recall or locate information to help them understand new algorithms or concepts.

Applied comprehension is necessary if students are to be able to demonstrate understanding by solving new problems, constructing demostrations of key principles, or determining relationships and trends among data. This level of comprehension requires that students perform the cognitive functions of analysis, synthesis, and evaluation in addition to literal and interpretive reasoning. Activities designed at the applied level are particularly important if students are to learn

to think critically and develop a full repertoire of life-long learning skills. The following figures represent teacher structed reading guides, also known as directed reading activities (DRA's), written for the purposes of engaging students in literal, interpretive, and applied comprehension.

Questions on the literal level include fill-in-the-blanks and matching.

Part 1. Short Answer.

There are several important details in this section of the chapter on "Our Water Supply." As you read, answer the questions assigned below.

1. _____is the name of a process used to separate water into its two gasses: _____ and _____ by using an electric current.

2. The volume of _____ gas is twice the amount of _____ gas.

3. What is a solvent?

4. What is a solute?

5. What is a solution?

6. What is adhesion?

7. What is cohesion?

8. What is surface tension?

9. Because of _____, surface tension in water is possible.

10. Because of _____, capillary action of water is possible.

11. Water pressure at a given depth is equal in _____ directions.

Part II. Matching.

Match the letter of the vocabulary word with its correct definition.

A. Adhesion	E. Solution
B. Capillarity	F. Solvent
C. Cohension	G. Surface Tension
D. Solute	

_____12. Liquid in which another substance is dissolved into it.

_____13. Substance that is dissolved into a liquid.

_____14. Mixture of solute and solvent.

_____15. Ability of unlike molecules to stick together.

_____16. Force of attraction between molecules of the same kind.

_____17. Attraction between molecules at the surface of a liquid.

_____18. Tendency of a liquid to rise in small tubes and into extremely small openings of porous objects.

Figure 19. Sample reading guide (literal level).

Reading activities written at the interpretative level include: cause/effect, comparison/contrast, time order, enumerative order, and main ideas.

Part I. Cause/Effect

After reading the chapter "Our Water Supply" in the textbook, answer the following questions over relationships on the properties of water. For each numbered effect, select the lettered cause that is most related.

Effects	Causes
_____1. Large drop of water form on the waxed surface of a car following a rain.	A. Water freezes.
_____2. We can go skating in an indoor rink.	B. Water changes to steam.
_____3. Very dirty clothes are washed in an automatic washer.	C. Water forms solutions.
_____4. Water flows from a faucet in an upstairs bathroom.	D. Water has surface tension.
_____5. Potatoes are cooked in a pressure cooker.	E. Water has cohesive properties.
_____6. A blotter absorbs ink which is 99% water.	F. Water has adhesive properties.
_____7. A porcelain dish comes out wet when dipped into dishwater.	G. Water illustrates capillarity.
_____8. We can use a sponge to wash a car.	H. Water exerts pressure.
_____9. We have factories that manufacture ice.	
____10. Large buildings are heated with radiators.	

Part II. Comparison/Contrast.

As you read the passage "Purifying Water" in your textbook, think about the four different steps presented in the purification process. On the following chart list, first, how these processes are similar; then, list how they are different.

Procedures	Similarities	Differences
Settling		
Filtering		
Chlorinating		
Aeration		

Part III. Time Order

After reading the chapter "The Crust of the Earth" in the textbook, study the "Geological Time Chart" included at the end of the chapter. Then, according to their order of appearance on earth, number the events from 1-10 with "one" representing the earliest event and "ten" representing the most recent event.

ORDER OF APPEARANCE	EVENTS
_____	Columbus discovered the New World.
_____	The planet Earth is formed.
_____	Oceans form and cool enough for first life.
_____	Development of Stone Age man.
_____	One-celled animals and plants appear.
_____	Mammals become the dominant life form.
_____	The development of the invertebrates.
_____	Beginning and end of the dinosaurs.
_____	Fish become the dominant life form.

Part IV. Enumerative Order.

As you read the passage "Forms of Moisture in the Atmosphere" in the textbook, think about the different steps that are involved in the formation of clouds. Then, number these conditions in the correct order.

ORDER	CONDITIONS FOR CLOUD FORMATION
_____	Rising water vapor.
_____	Evaporation occurs.

ORDER CONDITIONS FOR CLOUD FORMATION

_____Condensation of water on dust particles.

_____Heat from the sun warms the earth.

_____Cloud is formed.

_____Water absorbs heat energy.

Part V. Main Idea.

As you read the passage "What is Matter?" in the textbook, think about the main ideas presented. Then from the following list of statements, identify them as either "Main Idea" or "Supporting Detail" of the article.

_____1. Matter is anything that takes up space, exists in time, is impenetrable, and has mass.

_____2. Two books are bigger than one.

_____3. You can sit in a chair now and someone else can sit in it after you leave it.

_____4. Drive a nail into a board and the fibers spread apart to make room for the nail.

_____5. All matter is continually changing.

_____6. A balloon expands as you blow air from your lungs into it.

_____7. Mass is the measure of the quantity of matter in objects.

_____8. You have the same mass on the moon as you have on earth.

_____9. The mass of an object does not change.

_____10. The standard mass balances the same amount of material anywhere on the earth.

Figure 20. Sample reading guide (interpretive level).

Questions on the applied level include: demonstrations, mathematics, and the determining of relationships.

Part I. Demonstrations

As you read the passage "Why Do Ships Float On Water?" in the textbook, think about previous experiences of yours which apply to the concepts presented. Then, write-up and demonstrate an activity to show Archimedes' principle and the laws of flotation. (Note: This demonstration may be similar to the one in the textbook, but it can't be exactly the same.)

Part II. Mathematics.

After reading the passage, "Why Do Ships Float on Water?" in the textbook, study the mathematical formula for the determination of specific gravity. Then, using the formula for specific gravity, complete the following chart.

Weight of Substance	Weight of Equal Volume of Water	Specific Gravity	Does it float? (Yes or No)
108 pounds	40 pounds		
100 pounds	100 pounds		
50 pounds	100 pounds		

Part III. Determining Relationships.

After reading the chapter "Our Water Supply" in the textbook, think about the laws of flotation and how they operate. Then for each numbered statement, choose the correct relationship.

A. More Than B. Less Than C. The Same As

_____1. A ship floats because the water it displaces when floating weights __?__ the weight.

_____2. A submarine takes on water ballast so that it weighs __?__ the water it displaces submerged.

_____3. An object will remain at any certain distance under water when it weighs __?__ the water it displaces.

_____4. A boy cannot float in the swimming pool because he weighs __?__ the water he displaces.

_____5. The specific gravity of an object is 1.2. It must weigh __?__ the water it displaces.

Figure 21. Sample reading guide (applied level)

Summary

In addition to content acquisition, curriculum should be viewed as the development of learning skills. In fact, the teaching of one is dependent upon the other. Content cannot be approached by students without the necessary learning skills, nor can the skills be successfully taught without content as a vehicle.

The activities presented here are intended to serve as models for teachers in developing their own study and reading skill improvement activities. Teachers can adapt the ideas to meet their specific situations and various types of management can be employed where necessary. For example, large group instruction can be utilized when an entire class needs assistance, individualized instructional systems can be developed to help students with specific problems.

When using activities developed on reading and study skill strategies, a teacher will have an efficient and organized method for instruction which is flexible and permits the expansion of course content. Therefore, course content is not sacrificed for the sake of teaching reading and study skills. The instructional strategy "teaches" the skills while the teacher teaches science or mathematics. Content is thereby enchanced through technique.

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Appendix A.

Science Cloze Test Key
Figure 1

1. Science
2. of
3. gathered
4. of
5. world
6. But
7. science
8. problem
9. thinking
10. science
11. knowledge
12. thinking
13. a
14. the
15. would
16. for
17. tools
18. is
19. 50
20. of
21. of
22. one
23. say
24. body
25. Science
26. investigating
27. facts
28. unless
29. them
30. facts
31. method
32. discovers
33. Science
34. investigating
35. of
36. other
37. of
38. science
39. for
40. living
41. studying
42. elements
43. heat
44. the
45. substance
46. paper
47. facts
48. the
49. sets
50. also

Mathematics Cloze Test Key
Figure 2

1. with
2. the
3. numeral
4. a
5. Yet
6. in
7. years
8. as
9. tribes
10. count
11. suppose
12. trip
13. on
14. where
15. as
16. numeral
17. the
18. the
19. help
20. deeper
21. of
22. On
23. natives
24. at
25. note
26. by
27. one
28. three
29. indicates
30. numeral
31. of
32. Here
33. of
34. two
35. that
36. $32_{(seven)}$
37. three
38. two
39. decimal
40. need
41. because
42. base
43. in
44. numeral
45. of
46. or
47. 7
48. bases
49. must
50. we

Appendix B.

Informal Study Skills Inventory on a Physical Science Textbook

1. Take out your science book. Look at it while you count to five. Sit on it. Then answer the following upside down questions:

   a. What color is the book?
   b. Write as many words as you can remember from the cover (11 possible).
   c. Draw the picture from the front cover.
   d. Draw the picture from the back cover.
   e. You and a partner check and discuss each other's answers.

Now, take your book out again and answer the following questions:

2. Circle the date below that is closest to the copyright date of your book.

   1958 1962 1966 1970

3. Check the statement below that expresses what the author feels is the theme of this course

_____a. The exploration of biological aspects of all life

_____b. The development of evidence for an atomic model of matter

_____c. The investigation of the elements essential to ecological balance

_____d. The extension of ideas dealt with in the AAAS Science Program

4. Check below the section in the book where you found the answer to question #3.

_____a. Introduction

_____b. Table of Contents

_____c. Index

_____d. Preface

_____e. Epilogue

5. Number the following topics in the order they are dealt with in your textbook.

_____Molecular motion

_____Quantity of matter: mass

_____Solubility and solvents

_____Sizes and masses of atoms and molecules

_____Characteristic properties

6. The answers to question #5 were found (by me) in

_____Index _____Introduction

_____Contents _____Looking through the book

_____Epilogue _____My head

7. Look at Figure 1.1 and Figure 4.8. State three things that are the same in both pictures and three things that are different.

Same	Different
a._____	a._____
b._____	b._____
c._____	c._____

8. What do you think Fig. means in this book?

9. Take exactly 30 seconds and look at the pictures in the book.

10. Now, from your observation of the pictures, list or draw ten objects we will be using in science this year. (Don't look back!)

11. Put a circle around the number below that best expresses how many experiments we can deal with in this book.

19 29 39 49 59

12. On what page(s) can the following be found:

_____Calibration _____Dalton, John

_____Mass (unit of) _____Calorie (definition of)

_____Radioactivity (discovery of) _____Precipitate

_____Alcohol _____Geiger Counter

_____Marsh Gas _____Oxymuriatic Acid

13. At the end of the book the authors state what they hope you have gained from the course. Which of the following is not stated:

_____a. More expert experimenter

_____b. More critical reader

_____c. More careful observer

_____d. Sharper thinker

14. Look at the pages listed below. Then answer question #15.

p. 5 p. 9 p. 31 p. 32 p. 37 p. 41

p. 56 p. 74 p. 84 p. 88

15. Write between 13 and 17 words describing the difference between what the authors label Fig. and what they label Table.

16. Why is the picture on page 35 labeled Fig. rather than Table? Give your most logical guess.

17. On page 19, do the best you can on question #1.

18. Without turning around, answer the following:

    a. Is the person seated behind you a boy or a girl? (If you're in the back seat, use the person in the front seat of your row. Do not peek!)

    b. What color eyes does he/she have?

    c. What color clothes is he/she wearing?

19. List the steps to follow in doing Experiment #1.1 on pages 4 and 5.

20. a. Write the topic of the last article or book you have read concerning anything scientific.

    b. Write the topic of the last TV show you saw concerning anything scientific.

    c. Write the one most interesting thing you remember from your science course last year.

    d. Write the one most boring thing you remember from last year's science course.

    e. Write the one most difficult thing you remember from last year's science course.

21. Look on page 19. Read the two paragraphs in Section 2.14. Then, in one sentence, state the main idea expressed in the two paragraphs.

22. List in order everything you did from the time you woke up yesterday until the time you woke up this morning.

23. Write a copule of your own words stating what you think each of the following terms means. Do not look them up. If you don't know, guess.

a. apparatus
b. mass
c. solubility
d. graph
e. properties
f. volume
g. cm
h. scientific method
i. conservation
j. hypothesis

24. Look at the lab setup your teacher has prepared. List below all the things you think are wrong with the setup. Use your past experience and your head.

25. a. Write 3-5 words describing your feelings about science courses in general.

b. What have you heard about what to expect in this course?

NOTE: When all of the above questions have been completed and checked, proceed to question 26.

26. All of the above questions have somehow attempted to do which of the following:

a. familiarize you with this year's program

b. help you to learn to fool around with science stuff

c. help you and your teacher learn your strengths and "not-so-strengths" in what you will be doing this year.

27. In the space below, attempt in some manner to chart the questions that you have answered well and not so well. Put the question in categories you think they best fit. You may work with someone else if you like. You may use some of the categories listed and/or make up some of your own.

Observation skills
General information
Compare and contrast
Following directions
Interpretation
Location skills

(Developed by Scott L. Shablak of the Westhill, New York, Public School System.)

Appendix C

Student Study Skill Self Rating Checklist

Name	Good	Average	Need Help
1. Pronouncing and knowing the meaning of the words in a textbook.	_____	_____	_____
2. Using parts of textbooks	_____	_____	_____
3. Using the dictionary	_____	_____	_____
4. Knowing a good study method	_____	_____	_____
5. Outlining, summarizing and taking notes	_____	_____	_____
6. Locating materials in books and reference materials	_____	_____	_____
7. Writing a report	_____	_____	_____
8. Following printed directions	_____	_____	_____
9. Interpreting graphic aids	_____	_____	_____
10. Remembering material	_____	_____	_____
11. Taking tests	_____	_____	_____

Appendix D

Study Habits Self Report

Habits of Concentration	Rarely or Never	Sometimes	Often or Always
1. I find it hard to keep my mind on what I am studying	____	____	____
2. I desire a quiet place when trying to study	____	____	____
3. It takes me some time to settle down and get ready to study	____	____	____
4. I have to wait for "the mood to strike me" before starting a task, I am likely to waste time	____	____	____
Distribution of Time and Social Relationships			
5. My study time is unwisely distributed; I spend too much time on some subjects and not enough on others	____	____	____
6. My periods of study are interrrupted by outside interference such as telephone calls or distracting noise	____	____	____
7. I find it hard to force myself to finish work by a certain time	____	____	____
8. I study with others rather than by myself	____	____	____
9. I prefer to watch TV than do my homework	____	____	____
Reading and Note Taking Techniques			
10. I have to re-read material several times to get its meaning	____	____	____
11. I have trouble picking out the important points in material read or studies	____	____	____

	Rarely or Never	Sometimes	Often or Always
12. I go back and recite to myself the material, rechecking any points I do not understand	____	____	____
13. I pronounce the words to myself as I read	____	____	____
14. I miss important points while listening to the teacher; I do not take notes in class	____	____	____
General Habits and Attitudes of Work			
15. I get nervous on exams	____	____	____
16. I try to use the material I have learned in one course in other courses	____	____	____
17. I try to review the facts learned, associating them with previously learned material and facts	____	____	____
18. I find myself too bored to study efficiently most of the time	____	____	____
19. I dislike studying period	____	____	____

Appendix E

Some Vocabulary Words Common to Science and Math

area
connect
column
centimeter
coordinates
concave
convex
cylinder
digit
distance
degree
decimal
eclipse
equation
expand
factor
figure
gallon
group
graph
height
infinity
inquiry
identify
linear measure
liquid measure
metric
measure
measurement
member
minute
mid point
model
operation
opposite
parallel
principle
property
point
space
sequence
solve
sphere
separate
segment
shape
surface
solution
symmetry
symbol
subset
thermometer
temperature
time
unit
value
vertical
volume
weight
width

Appendix F

Solving Science/Math Reading Problems

Prediction Worksheet

1. Give students copies of the Problem Prediction Sheet.
2. Have students work through the sheet with a problem which the students would find very easy to solve.
3. Direct students through the worksheet with more difficult problem.
4. Repeat the use of the worksheet whenever new types of reading problems are introduced to the students so that they have an opportunity for directed practice with thoughtful systematic problems.

1. Numbers the reading gave me

   A.

   B.

   C.

2. Questions the reading asked me

   A.

   B.

   C.

3. What could an answer to those questions be? (GUESS)

   A.

   B.

   D.

4. Could the number I guessed be too high (jot down a reason whether you circle yes or no)

   A. Yes No _____

   B. Yes No _____

   C. Yes No _____

5. Could the number I guessed be too low

   A. Yes No _____

   B. Yes No _____

   C. Yes No _____

6. Should I guess again?

   A. Yes No _____

   If the answer is yes, reread your problem and go back to 3 and answer the questions again.

   If the answer is no, begin to work your problem

Excerpted from Smith & Elliot, 1979, p. 191

Appendix G

Solving Word Problems

Area: Mathematics (Word Problem)

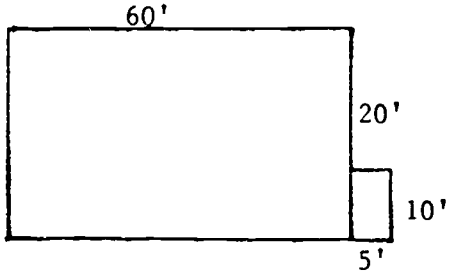
Grade: Eighth

Organizing Idea: The area of multiple rectangular regions can be computed by merely combining the areas of single regions that make up the whole.

Instructional Option: Levels of comprehension

WORD PROBLEMS--RECTANGULAR REGIONS

Problem: Lorenzo and Maria are buying sod for their backyard and connecting dog run. Here is a sketch of the area.



If sod costs $.75 a square foot, how much will it cost to cover the area with sod?

Part I

Check all the items which correctly identify information contained in the problem and what is to be found.

_____1. Lorenzo and Maria are improving their property.

_____2. Their dog run is square.

_____3. The dog run is smaller than the yard.

_____4. The back vard is rectangular.

_____5. The back yard is square.

_____6. Lorenzo and Maria have a dog.

_____7. A square foot of sod costs less than a dollar.

What is to be found?

_____a. The cost of the sod for the dog run.

_____b. The cost of the sod for the yard.

_____c. The total cost of the sod.

_____d. The cost of each square foot of sod.

_____e. The size of the house.

_____f. The color of the house.

_____g. The area of the dog run.

_____h. The area of the yard.

_____i. The length of fence around the dog run.

Part II.

Check the following items which identify operations needed to solve this problem.

_____1. Length multiplied by width.

_____2. Length multiplied by width added to length multiplied by width.

_____3. Square feet multiplied by cost per square foot.

_____4. Area times cost.

_____5. Length times width plus length times width times cost.

_____6. Length times width times cost plus length times width times cost.

_____7. l X w = A

_____8. l X W x $ = cost

_____9. (30 X 60 X $.75) + (5 X 10 X $.75) =

____10. (30 X 60) + (10 X 5) X $.75 =

Part III

Check the following statements that express ideas about mathematics found in your problem.

_____1. Areas of quadrilaterals can be found by multiplication.

_____2. Areas of rectangular regions can be found by multiplication and addition.

_____3. Areas of quadrilaterals can be found by addition.

_____4. Finding the cost of covering an area is a two-step process.

_____5. Other